



Europäisches Patentamt
European Patent Office
Office européen des brevets



⑪ Publication number: 0 451 828 A2

(12) **EUROPEAN PATENT APPLICATION**

② Application number: 91105708.1

⑤1 Int. Cl.5: B41J 11/48, B41J 13/12

22 Date of filing: 10.04.91

③ Priority: 11.04.90 JP 95975/90

(43) Date of publication of application:
16.10.91 Bulletin 91/42

⑧ Designated Contracting States:
BE DE ES FR GB IT NL

⑦ Applicant: CANON KABUSHIKI KAISHA
30-2, 3-chome, Shimomaruko, Ohta-ku
Tokyo(JP)

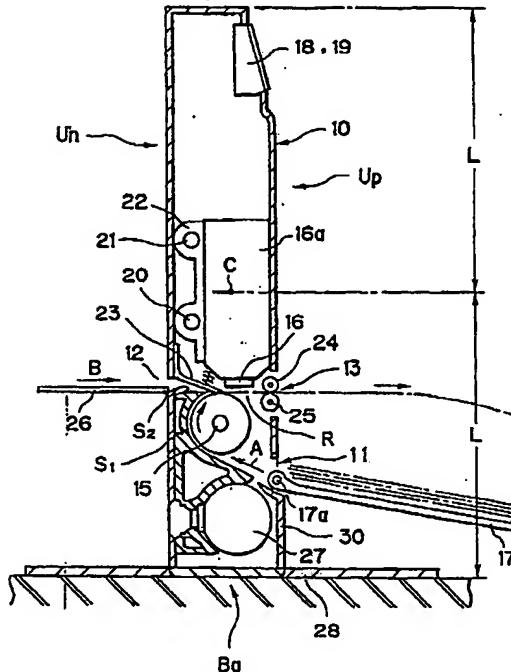
② Inventor: Kashimura, Makoto, c/o Canon
Kabushiki Kaisha
30-2, 3-chome, Shimomaruko
Ohta-ku, Tokyo(JP)

74) Representative: Tiedtke, Harro, Dipl.-Ing.
Patentanwaltsbüro Tiedtke-Bühling-Kinne-
Grupe-Pellmann-Grams Bavarlaring 4
Postfach 20 24 03
W-8000 München 2(DE)

54 Recording apparatus.

57 A recording apparatus for recording onto a recording medium comprises a U-turn passage having a passage for guiding the recording medium from upper to under side, a straight-like passage having a passage for guiding the recording medium almost horizontally, a common passage connecting said U-turn passage and said straight-like passage, and recording means for recording onto the recording medium provided along said common passage.

FIG. 4



EP 0 451 828 A2

BACKGROUND OF THE INVENTIONField of the Invention

The present invention relates to a recording apparatus for recording onto a recording sheet based on image information.

Related Background Art

A recording apparatus such as a printer, a copying machine and a facsimile terminal equipment is constituted to record an image consisting of dot patterns onto a sheet-like recording medium (hereafter referred to as a recording sheet) such as paper or plastic thin board, by driving energy generation means of recording head, based on image information.

The recording apparatus can be classified into the ink jet printing, wire dot-matrix printing, thermal recording and laser beam printing systems, according to the method of recording.

As a recording sheet useful for recording, there is a thick paper such as an envelope or postcard, or a special sheet such as a plastic thin board, as well as a plain paper.

Here, the recording apparatus, which is generally a horizontal type, has an insertion opening and an exhaustion opening for recording sheet which are provided on an upper face of recording apparatus. A recording sheet inserted through the insertion opening is recorded while being conveyed along a recording sheet conveyance passage constructed as a U-shape, and then exhausted through the exhaustion opening after recording.

By the way, there was a technical problem that when a nervy recording sheet such as a postcard or envelope was used in the horizontal type recording apparatus as above described, smooth conveyance was difficult as the sheet conveyance passage was formed as U-shape.

Thus, in order to convey the nervy recording sheet such as a postcard or envelope smoothly, a recording apparatus has been proposed in which an insertion opening for thick paper or special sheet is provided on an under face of apparatus to make its conveyance passage straight-like, whereby recording sheet such as a thick paper can be also conveyed smoothly.

In this case, the insertion opening for recording sheet is provided on upper and lower (bottom) faces, and the exhaustion opening for recording sheet is provided on an upper face.

However, the recording apparatus having the insertion opening for recording sheet on upper and lower faces, as previously described, has two service conditions (attitudes), i.e., horizontal and vertical, depending on the insertion direction of record-

ing sheet, and in order to be stable in either condition, an external shape of recording apparatus must be almost cube with the approximately same depth and height, resulting in a waste space in the interior.

Moreover, with the recent rapid trend of miniaturized and low cost personal computer, the recording apparatus like a printer useful as an output apparatus is also demanded to be made small-sized and at lower cost.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a recording apparatus which allows the externals to be smaller.

Another object of the present invention is to provide a recording apparatus with a simple structure and lower cost.

Another object of the present invention is to provide a recording apparatus which can deal with a special recording sheet such as a thick paper and can make the excellent recording.

Another object of the present invention is, in view of the aforementioned technical problems, to provide a recording apparatus which can be used stably in either of the horizontal and vertical conditions, and allows the miniaturization of externals, simplification of structure, and reduction of cost.

Another object of the present invention is to provide a recording apparatus for recording onto a recording sheet based on image information, wherein the recording apparatus can be used stably in either of the horizontal and vertical conditions, and allows the miniaturization of externals, simplification of structure, and reduction of cost, by providing an insertion opening for recording sheet on the identical and opposite sides to an exhaustion opening for recording sheet and providing a rotatable support saddle on a back portion of the recording apparatus.

Another object of the present invention is to provide an ink jet recording apparatus using an ink jet recording head and having a battery mechanism, which can maintain the stable service condition, wherein it is constituted to have a rotatable support saddle on an external surface of recording apparatus on the hand of battery mechanism storage portion so as to place the center of gravity substantially and surely in a lower location in the vertical service condition.

Another object of the present invention is to provide an ink jet recording apparatus having an ink jet recording head and a battery mechanism, wherein it can perform the stable recording in either of the vertical and horizontal service conditions for the apparatus, by providing a support saddle on the hand of battery mechanism thereby to resolve

misoperation problem resulting from the advantage of having no limitations in the service condition of ink jet recording head.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a perspective view showing one example of a recording apparatus to which the present invention is applied, in the horizontal service condition.

Fig. 2 is a perspective view showing a back portion of the recording apparatus as shown in Fig. 1, during the non-recording.

Fig. 3 is a perspective view showing the recording apparatus as shown in Fig. 1, in the vertical service condition.

Fig. 4 is a longitudinal cross-sectional view showing the apparatus as shown in Fig. 3, in the vertical service condition.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention will be specifically described with reference to the drawings.

Fig. 1 is a perspective view showing a recording apparatus 10 according to one example of the present invention, in the horizontal service condition, Fig. 2 is a perspective view showing a back portion of the recording apparatus 10 as shown in Fig. 1. Further, Fig. 3 is a perspective view showing the recording apparatus 10 as shown in Fig. 1, in the vertical service condition. Still further, Fig. 4 is a longitudinal cross-sectional view showing an internal construction of the apparatus 10 as shown in Fig. 3, in the vertical service condition.

In Figs. 1-4, the recording apparatus 10 is an ink jet recording apparatus with the ink jet recording method for recording an image onto a recording sheet 14 by discharging the ink through discharge ports of a recording head by the use of electricity-heat converters for forming ink liquid droplets.

As clearly seen from the figures, it should be noted that the recording apparatus 10 of this example is normally used in the horizontal service condition (as shown in Fig. 1), while in the vertical condition, it is used in the standing attitude with a back portion Ba being placed on the under face and an upper face Up as the front face.

On the upper face Up of the recording apparatus 10, a first insertion opening for recording sheet 11 and an exhaustion opening for recording sheet 13 are provided. A recording sheet 14 inserted through the first insertion opening for recording sheet 11 is closely carried on a peripheral surface of platen roller 15 (Fig. 4) which is also used as sheet feed roller, and conveyed in the direction of

the arrow A along a first recording sheet conveyance passage S1. That is, as shown in Fig. 4, the recording sheet manually inserted from an upper cover 17b through the sheet insertion opening 11 is conveyed by the platen roller 15 and exhausted through the sheet exhaustion opening 13. The above mentioned recording sheet 14 inserted through the sheet insertion opening 11 passes through a position opposed to recording head 16 (Fig. 4), where an image is recorded by the recording head 16, and is exhausted upward (forward in the vertical type) through the sheet exhaustion opening 13 after recording.

The upper cover 17 is fitted, in an openable or closable manner, into place on an upper face of the recording apparatus 10, wherein it is used as a paper feed tray or exhaustion tray in an open state during recording, as shown in Fig. 1, and is set to a closed position during non-recording (reverse or storage) as shown in Fig. 2.

The upper cover 17 has a feature of covering and protecting an upper face Up of recording apparatus 10 in the closed state, in which the first recording sheet insertion opening 11, the recording sheet exhaustion opening 13, switches 18, a display 19 and so on are disposed.

As shown in Fig. 4, the recording head 16 is mounted on a carriage 22 movable in a reciprocatory motion along guide shafts 20, 21 parallel to the platen roller 15.

Note that the recording head as shown in an instance of ink jet recording head, in which an ink tank for storing the ink and the head are integrally formed as an exchangeable head cartridge for the recording apparatus 10. Also, the recording head 16 may be formed separately from the ink tank.

Further, the ink jet recording head 16 is a recording head for discharging the ink by the use of the heat energy with electricity-heat converters for generating the heat energy.

Also, the ink jet recording head 16 makes the recording by discharging the ink through the discharge ports by growth of bubbles owing to film boiling caused by the heat energy applied by the electricity-heat converters.

Further, a sheet presser plate 23 for pressing a recording sheet 14 against the platen roller 15 is placed upstream of the recording head 16 in the conveyance direction, and elastically biased onto a periphery of platen roller 15 by means of a spring 35 provided between main body of apparatus and the presser plate 23.

Further, a spur 24 having teeth around its periphery and an exhaustion roller 25 to aid in the exhaustion of recording sheet 14 are disposed in the recording sheet exhaustion opening 13.

Next, the vertical service condition of the recording apparatus 10 will be described with refer-

ence to Figs. 3 and 4.

On the rear face Un (back face in the vertical condition) of the recordings apparatus 10, a second recording sheet insertion opening 12 is provided. And a second recording sheet conveyance passage S2 is formed in substantially straight shape, leading from the recording sheet insertion opening 12 through a recording portion R between the recording head 16 and the platen roller 15 to the recording sheet exhaustion opening 13.

This second recording sheet conveyance passage S2 can easily feed a nervy recording sheet 26, such as a thick recording sheet such as a postcard or envelope, or a special recording sheet as a plastic sheet, because of its substantially straight shape

For example, the recording sheet or special recording sheet 26 is inserted in the direction of the arrow B as indicated in Fig. 3, passed through the recording portion R, exhausted out of the recording sheet exhaustion opening 13, and stacked onto a paper exhaustion tray formed by the upper cover 17 placed in the open state around an axis 17a.

A support saddle 28 is mounted to be rotatable (for storage and overhang) on a back portion Ba (or an under face Un in the vertical attitude shown in Figs. 3 and 4) of the recording apparatus 10. In the example as shown, the support saddle 28 is rotatably mounted around an axis 29 within a recess 36 depressed by almost a thickness of support saddle 28 which is provided on the back portion Ba.

When the recording apparatus 10 is used in the vertical attitude, the support saddle 28 is rotated to the overhang position where it is approximately orthogonal to the body of recording apparatus 10. Thereby, the recording apparatus 10 can be stably supported in the vertical attitude, and can be placed in a stale condition for inserting the recording sheet 14, or operating the switches 18.

On the other hand, when the recording apparatus 10 is used in the horizontal attitude, or put into storage, the support saddle 28 is rotated into a withdrawal position almost parallel to the recording apparatus 10, as shown in Fig. 2, so that the support saddle 28 can be set to the state where it is no obstacle to the recording apparatus 10 in the horizontal attitude, thereby not impeding the storage or transport.

In this example, particularly the support saddle 28 provided on the back portion Ba of recording apparatus 10 serves as a backup for a battery cover 30 for carrying a battery 27 contained in the back portion Ba of the apparatus, so that the battery cover 30 detachable from the main body can not be easily disengaged owing to the vibration or impact.

It should be noted that when using an ink jet recording head 16, the battery 27 is served as a driving source for the heat driving of the ink jet recording head 16 or the serial reciprocation driving in recording, or recovery means for performing well-known head recovery processing such as suction or pressure recovery, cleaning, etc., in accordance with the timer for deciding the non-use period or its decision result, when the apparatus is left away for a long time or intermittently used. The battery 27 may be a battery mechanism such as an accumulator or solar battery as well as battery.

As previously described, this example is a recording apparatus using the ink jet recording head 16 and the battery mechanism 27, wherein in the horizontal service condition, the battery mechanism 27 is arranged to place its large surface (back portion Un) of almost rectangular parallelopiped on the bottom face, as seen from Fig. 2, so that the apparatus can be used stably without substantially changing the center of gravity. In the vertical service condition, by means of the support saddle 28 provided in the vicinity of the battery mechanism as seen from Fig. 4, an operator can use the apparatus with the support saddle 28 placed on the bottom without false operation, whereby the recording is performed with the center of gravity being necessarily placed in a lower part of the apparatus 10. In this case, the support saddle 28 serves to put the apparatus into an extremely stable state due to the cooperation with the battery mechanism 27.

Note that the end portions 281, 282 of support saddle 28 in the longitudinal direction are shaped like circular arcs, as shown in Fig. 2. This contour is intended to distribute evenly the load applied thereto from the external and absorb it all over the surface of support saddle 28. This circular arc shape is one in which the end portion 282 is a circular arc with the radius R1, and the end portion 281 with the radius R2, with the center of rotation in the support saddle 28. The support saddle 28 has preferably the same lengths from the center of rotation 29 to the end portions 281, 282 (i.e., R1 = R2), but may have different lengths, depending on the balance of the apparatus 10.

With different lengths, the rotational direction of support saddle 28 is limited within a range of 180°, thereby its service conditions being restrained.

It should be noted that the rotatable support saddle 28 is preferably made of the same material as that for the main body of apparatus, and it is more preferred that in the vertical service condition, the support saddle is held in position crosswise to the apparatus body on the central portion thereof, while in the horizontal service condition, it is held in position of being substantially accommodated within an external face of the apparatus body. A well-

known stop mechanism is used in which a combination of a rib for stopping the rotation and a rib which is ridden over by the support saddle but serves as a stop with a slight amount of working force or a hook mechanism is applicable.

In Fig. 4, above the support saddle 28 forming the under face, there is shown the battery mechanism 27, above which are located a conveyance mechanism such as platen roller 15, and further the ink jet recording head 16 in a downwardly directed recording form (for discharging the ink downwardly), with the center C of the apparatus body 10 with height 2L being located at the ink tank 16a for recording head 16. Thereby, according to this example, when the ink jet recording head 16 is formed as a disposable or replaceable type, the amount of ink storage within the ink tank 16a is decreased during the consumption for recording, while most of the weight of whole apparatus is located lower than the center C, so that the vertical service condition can be made more stably.

As described, according to this example, the recording sheet insertion openings 11, 12 are provided on an upper face Up and an under face Un of recording apparatus 10, and the recording sheet exhaustion opening 13 is provided on the upper face Up of recording apparatus 10. Also, the recording sheet insertion openings 11, 12 are provided on the identical and opposite faces to the recording sheet exhaustion opening 13, respectively, and the rotatable support saddle 28 is provided on a back portion of the recording apparatus 10. Thus, the recording apparatus 10 can be operated stably even when used in the vertical attitude, with an extremely simple, compact and inexpensive construction. When the apparatus is used in the stable horizontal attitude, the support saddle 28 is no obstacle without projecting out of the apparatus body because it can be contained within the recess 36, whereby the apparatus which can be placed in very compact and convenient state for receiving, storing or transporting of the apparatus 10 has been obtained.

In the previous example, the support saddle 28 is constituted to be rotatably carried about the axis 29 of the apparatus 10, whereas it can be constituted such that a portion corresponding to the axis 29 is formed integrally with the support saddle 28, using a plastic, and is rotatably fitted forcedly into the apparatus 10 with the elasticity of the plastic. With such a constitution, a further reduction of cost can be achieved.

Also, in the previous example, one support saddle 28 is mounted, but two or more same support saddles can be mounted. Thus, by providing more than one support saddle, the length of support saddle can be shortened, and the occupation area of the apparatus 10 in the vertical attitude

can be further reduced, so that the space efficiency in the use of apparatus is improved, and the stability of the apparatus 10 can be increased.

While in the above example, the present invention is applied to an ink jet recording apparatus, it should be understood that the present invention is similarly applicable to other type recording apparatus such as the wire-dot printing or thermal imprint recording method and can thereby accomplish the same effects.

Also, while in the above example, the present invention is applied to a serial scanning type recording apparatus using a recording head in a so-called serial scan method where the recording head 16 is mounted on carriage 22, it should be understood that the present invention is also applicable to a recording apparatus with other recording method, such as a line type recording apparatus using a line type recording head which covers recording area in the direction of paper width for a recording medium, and can accomplish the same action effects.

The present invention is similarly applicable to a recording apparatus using a plurality of recording heads such as a color recording apparatus, irrespective of the number of recording heads, and can accomplish the same effects.

Next, the ink jet recording apparatus will be described in more detail in which the recording is performed by discharging the ink through the discharge ports by the use of the heat energy of electricity-heat converters as the energy for recording.

As to its representative constitution and principle, for example, one practiced by use of the basic principle disclosed in, for example, U.S. Patents 4,723,129 and 4,740,796 is preferred.

This system is applicable to either of the so-called on-demand type and the continuous type. Particularly, the case of the on-demand type is effective because, by applying at least one driving signal which gives rapid temperature elevation exceeding nucleus boiling in recording liquid corresponding to the recording information on electricity-heat converters arranged corresponding to the sheets or liquid channels holding a recording liquid (ink), heat energy is generated at the electricity-heat converters to effect film boiling in the recording liquid near the heat acting surface of the recording head, and consequently the bubbles within the recording liquid can be formed corresponding one by one to the driving signals.

By discharging the recording liquid through an opening for discharging to the atmosphere by the action force arising in the growth and shrinkage process of the bubble, at least one droplet is formed.

By making the driving signals into pulse

shapes growth and shrinkage of the bubble can be effected instantly and adequately to accomplish more preferably discharging of the recording liquid particularly excellent in response characteristic. As the driving signals of such pulse shape, those as disclosed in U.S. Patents 4,463,359 and 4,345,262 are suitable.

Further excellent recording can be performed by employment of the conditions described in U.S. Patent 4,313,124 of the invention concerning the temperature elevation rate of the above-mentioned heat acting surface.

As the constitution of the recording head, in addition to the combination of the discharging orifice, liquid channel, and electricity-heat converter (linear liquid channel or right-angled liquid channel) as disclosed in the above-mentioned respective specifications, the constitution by use of U.S. Patent 4,558,333, or 4,459,600 disclosing the constitution having the heat acting portion arranged in the flexed region is also included in the present invention.

Further, as the recording head of the full line type having a length corresponding to the maximum width of a recording medium which can be recorded by the recording device, either the constitution which satisfies its length by a combination of a plurality of recording heads as disclosed in the above-mentioned specifications or the constitution as one recording head integrally formed may be used, and in either case, the present invention can exhibit the effects as described above further effectively.

In addition, the present invention is effective for a recording head of the freely exchangeable chip type which enables electrical connection to the main device or supply of ink from the main device by being mounted on the main device, or a recording head of the cartridge type having an ink supply tank integrally provided on the recording head itself, as described in connection with the previous example.

Also, addition of a restoration means for the recording head, a preliminary auxiliary means, etc. provided as the constitution of the recording device of the present invention is preferable, because the effect of the present invention can be further stabilized.

Specific examples of these may include addition of, for the recording head, capping means, cleaning means, pressurization or suction means, electricity-heat converters or another type of heating elements, or preliminary heating means according to a combination of these, and it is also effective for performing stable recording to perform preliminary mode which performs predischarging separate from recording.

Further, as the recording mode of the record-

ing device, the present invention is extremely effective for not only the recording mode only of a primary color such as black etc., but also a device equipped with at least one of plural different colors or full color by color mixing, whether the recording head may be either integrally constituted or combined in plural number.

Still further, though the ink is considered as the liquid in the sample of the present invention as above described, other ink may be also sufficient if it liquefies or softens by a recording signal issued thereto, even when it stiffens below the room temperature.

The most effective method for the ink as above described in the present invention is one based on the film boiling as above indicated.

As clearly seen from the above description, according to the present invention, a recording apparatus capable of performing an excellent recording in either of the vertical or horizontal attitude can be obtained.

A recording apparatus for recording onto a recording medium comprises a U-turn passage having a passage for guiding the recording medium from upper to under side, a straight-like passage having a passage for guiding the recording medium almost horizontally, a common passage connecting said U-turn passage and said straight-like passage, and recording means for recording onto the recording medium provided along said common passage.

Claims

1. A recording apparatus for recording onto a recording medium comprising:
a U-turn passage having a passage for guiding the recording medium from upper to under side;
a straight-like passage having a passage for guiding the recording medium almost horizontally;
a common passage connecting said U-turn passage and said straight-like passage; and
recording means for recording onto the recording medium provided along said common passage.
2. A recording apparatus according to claim 1, wherein an inlet of said U-turn passage and an outlet of said common passage are disposed on the identical side to the recording apparatus body.
3. A recording apparatus according to claim 1, wherein an inlet of said U-turn passage and an inlet of said straight-like passage are disposed on the opposite sides to the recording apparatus body.

4. A recording apparatus according to claim 1, wherein a common conveying roller is provided along said U-turn passage and said straight-like passage.

5. A recording apparatus according to claim 1, wherein said recording apparatus records onto the recording medium while conveying the recording medium along said U-turn passage in a state where the body is laid in the horizontal condition.

6. A recording apparatus according to claim 1, wherein said recording apparatus records onto the recording medium while conveying the recording medium along said straight-like passage in a state where the body is placed in the vertical condition.

7. A recording apparatus according to claim 1, wherein said recording apparatus comprises a battery mechanism located in a lower portion of the apparatus body in the state where the body is placed in the vertical condition.

8. A recording apparatus according to claim 1, wherein said recording apparatus has an ink jet recording head, said ink jet recording head moving serially.

9. A recording apparatus according to claim 1, wherein said recording apparatus has an ink jet recording head, said ink jet recording head being one for discharging the ink by the use of the heat energy, and comprising electro-thermal converters for generating said heat energy.

10. A recording apparatus according to claim 9, wherein said ink jet recording head discharges the ink by the use of the pressure change by growth of bubbles owing to the heating of ink exceeding film boiling caused by said electro-thermal converters.

11. A recording apparatus according to claim 1, wherein said recording apparatus has a support saddle for stabilizing the main body in the vertical service condition.

12. A recording apparatus for recording onto a recording sheet by means of a recording head, based on image information, characterized in that an insertion opening for recording sheet is provided on the identical and opposite sides to an exhaustion opening for recording sheet, and a rotatable support saddle is provided on a back portion of the recording apparatus.

5. A recording apparatus according to claim 12, wherein said recording head is an ink jet recording head for discharging the ink by the use of the heat energy, and comprises electro-thermal heat converters for generating the heat energy.

10. A recording apparatus according to claim 13, wherein said ink jet recording head discharges the ink through discharge ports by growth of bubbles due to film boiling caused by the heat energy applied by said electro-thermal converters.

15. A recording apparatus comprising a battery unit for driving an internal mechanism within the apparatus, and using an ink jet recording head as a recording head, characterized in that said recording apparatus has at least two conditions of the horizontal and vertical services and is formed as a substantially rectangular parallelopiped wherein the maximum external face is the bottom face in the horizontal service condition, while an external face smaller than said maximum external face is the bottom face in the horizontal service condition, comprising said battery on the hand of said small external face as well as a rotatable support saddle on its external.

20. A recording apparatus according to claim 15, wherein said support saddle has an end portion of circular arc plane in the longitudinal direction, enabling said vertical service condition crosswise to the apparatus body, and wherein in the vertical service condition, an ink tank of said ink jet recording head is located on a central portion of height, below which a discharge unit of recording head is located, and further below, said battery is located.

25. A recording apparatus according to claim 16, wherein said support saddle has an end portion of circular arc plane in the longitudinal direction, enabling said vertical service condition crosswise to the apparatus body, and wherein in the vertical service condition, an ink tank of said ink jet recording head is located on a central portion of height, below which a discharge unit of recording head is located, and further below, said battery is located.

30. A recording apparatus according to claim 15 or 16, wherein said recording head is an ink jet recording head for discharging the ink by the use of the heat energy, and comprises electro-thermal converters for generating the heat energy.

35. A recording apparatus according to claim 15 or 16, wherein said recording head is an ink jet recording head for discharging the ink by the use of the heat energy, and comprises electro-thermal converters for generating the heat energy.

40. A recording apparatus according to claim 13, wherein said ink jet recording head discharges the ink through discharge ports by growth of bubbles due to film boiling caused by the heat energy applied by said electro-thermal converters.

45. A recording apparatus according to claim 13, wherein said ink jet recording head discharges the ink through discharge ports by growth of bubbles due to film boiling caused by the heat energy applied by said electro-thermal converters.

50. A recording apparatus according to claim 13, wherein said ink jet recording head discharges the ink through discharge ports by growth of bubbles due to film boiling caused by the heat energy applied by said electro-thermal converters.

55. A recording apparatus according to claim 13, wherein said ink jet recording head discharges the ink through discharge ports by growth of bubbles due to film boiling caused by the heat energy applied by said electro-thermal converters.

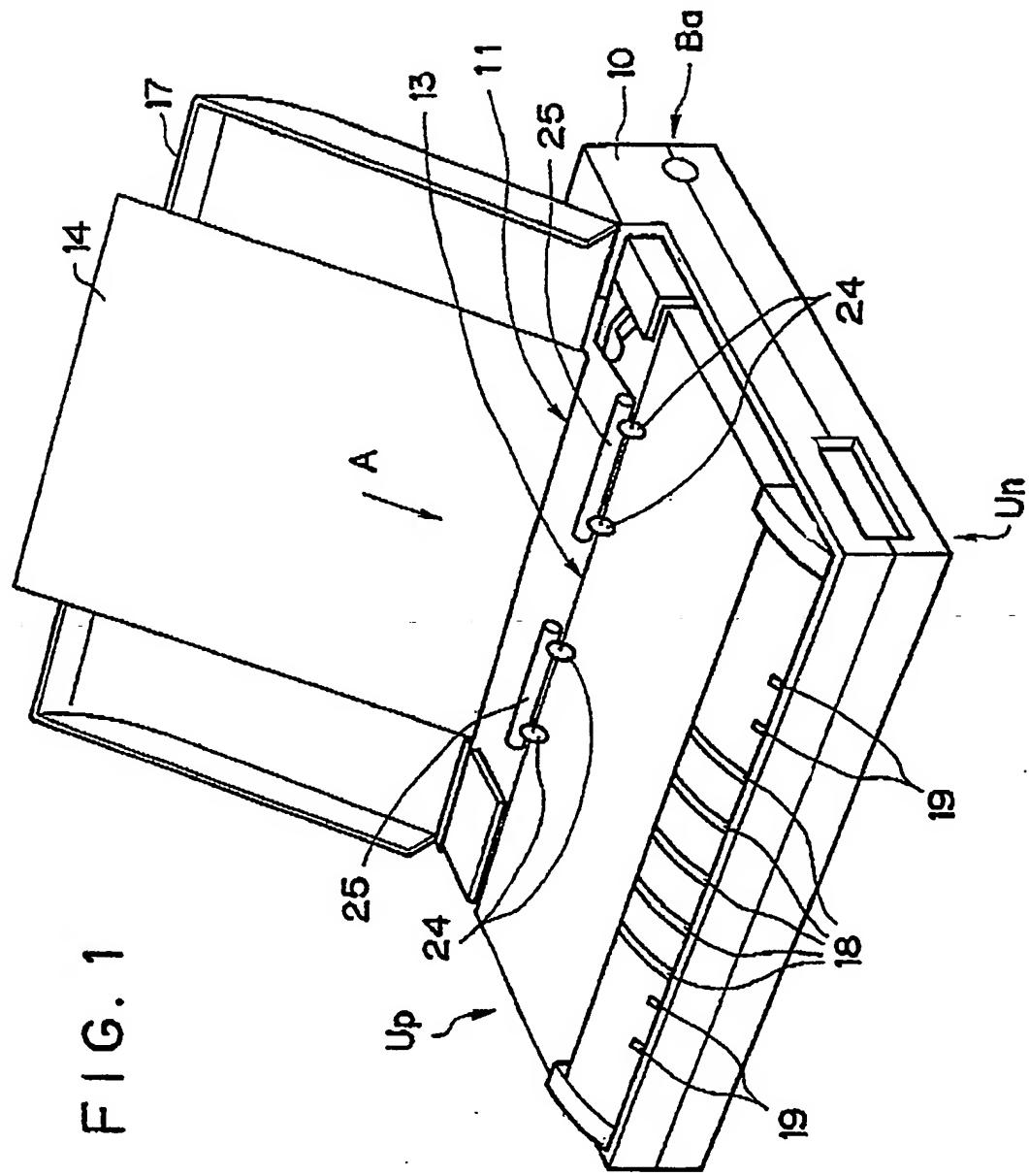


FIG. 2

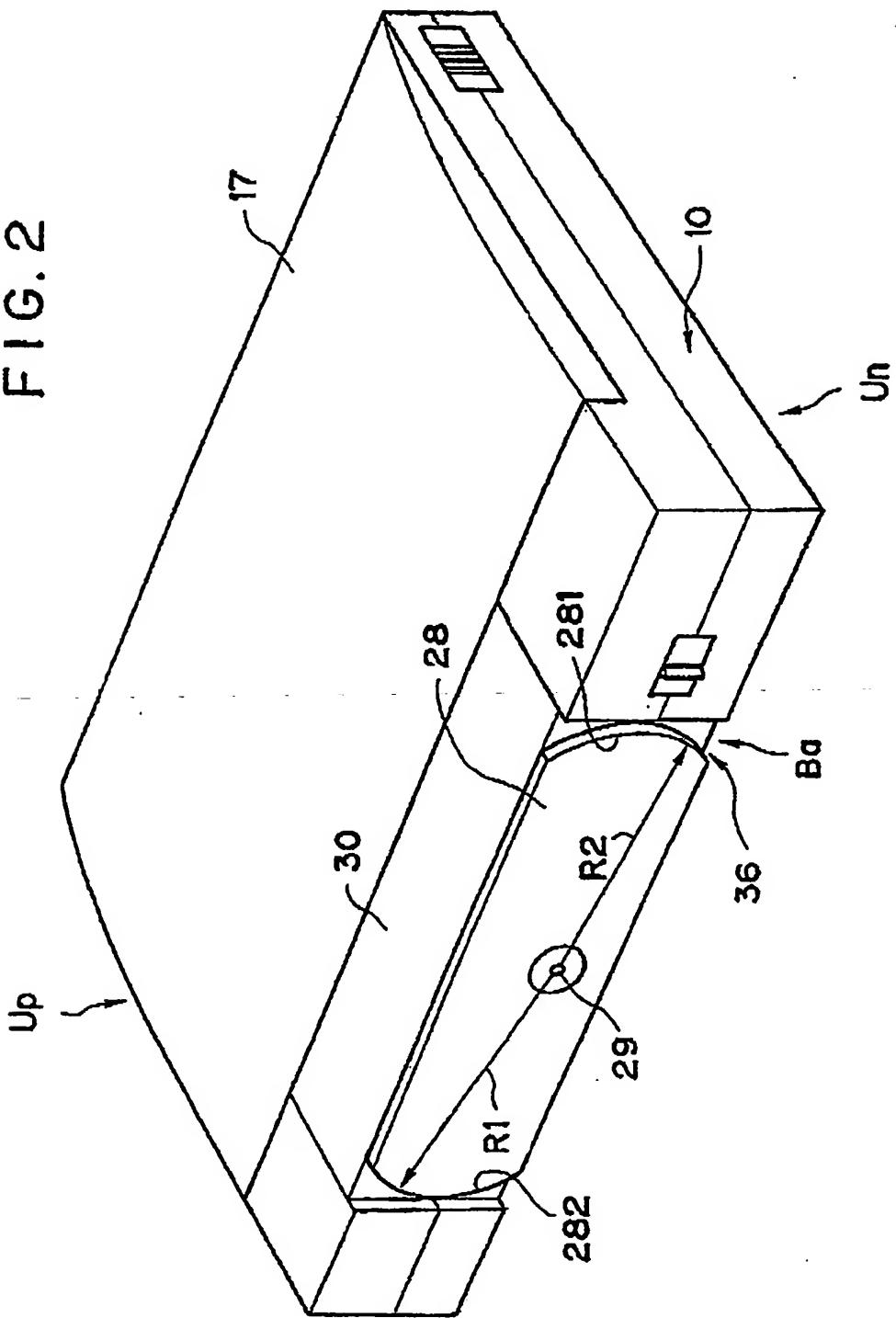


FIG. 3

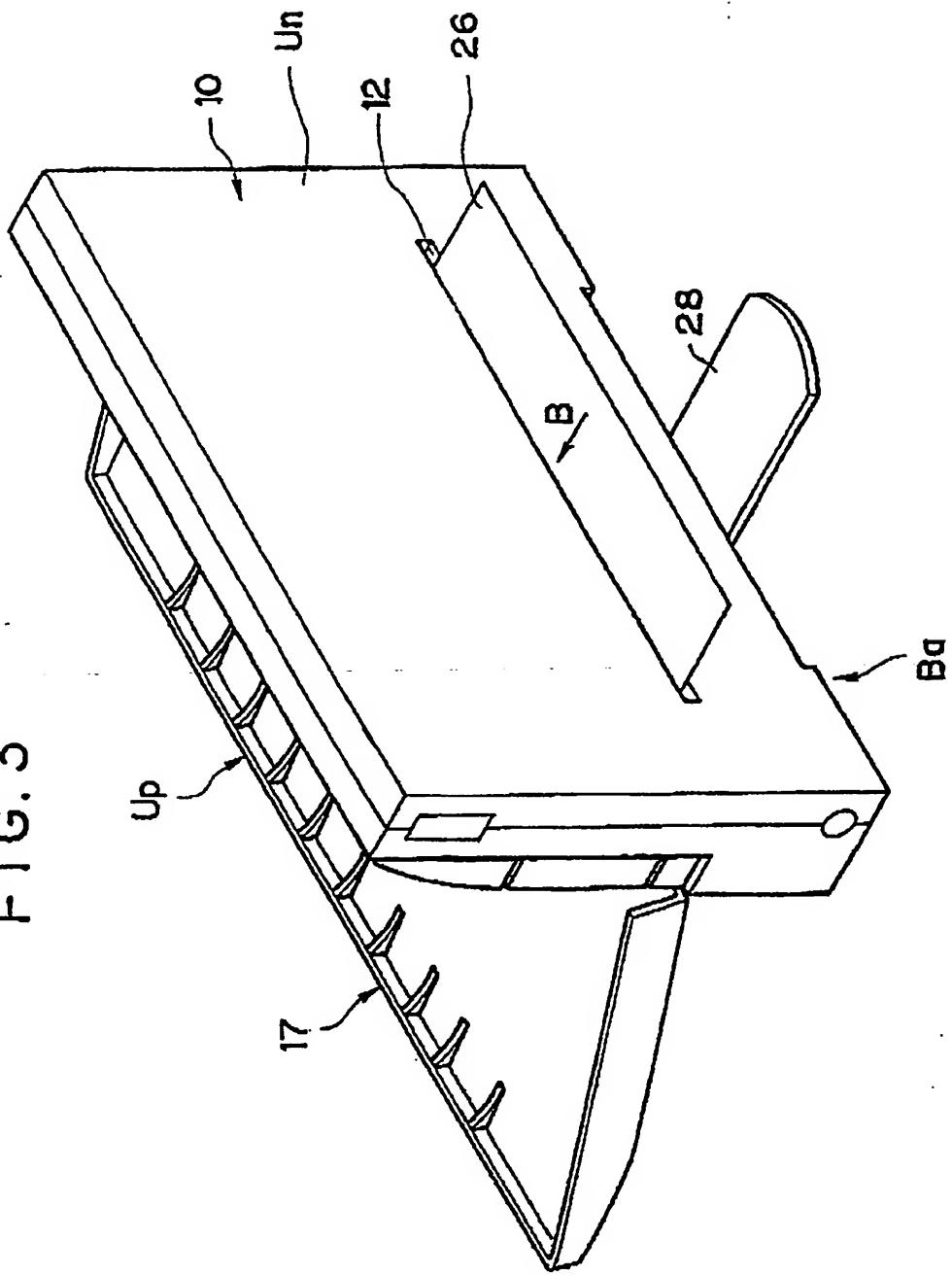


FIG. 4

